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# **APPRENTICESHIP TRAINING**

## **COMMUNICATION ELECTRICIAN Program**

### **Line and Station Craft**

The logo for the province of Alberta, featuring a stylized 'A' that incorporates a mountain range and the word 'Alberta' in a bold, sans-serif font.

**MANPOWER**  
Apprenticeship and  
Trade Certification Division



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## **COURSE OUTLINE**

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## **COMMUNICATION ELECTRICIAN TRADE LINE AND STATION CRAFT**

### **THE GOAL OF APPRENTICESHIP TRAINING**

To develop a competent tradesman who, through skill and knowledge, is capable of installation, diagnosis and repair of equipment as used in the Line and Station Craft of the Telecommunication Industry.

### **THE PRODUCT OF APPRENTICESHIP—**

a graduate who will:

Have a thorough knowledge of electrical and electronic theory and its application to communication and associated equipment used in the Line and Station Craft of the Telecommunication Industry.

- \* Be competent in the use of test instruments and understand their capabilities and limitations.
- \* Have the dexterity and skill to carry out the mechanical functions of completing repairs.
- \* Be familiar with the different circuit combinations and components.
- \* Be capable of utilizing test procedures to locate faults and isolate defective components.
- \* Understand the relationship and acquire appreciation of principles and concepts as applied to equipment in various craft areas of the trade.



# **COMMUNICATION ELECTRICIAN — LINE AND STATION CRAFT APPRENTICESHIP INFORMATION**

## **Basic Requirements:**

- \* Indenture for four periods of Trade experience.
- \* Attend a six week technical training course in the first, second, third and fourth periods.
- \* Fulfill the requirements for each period including 1800 hours of work experience inclusive of time spent at the training course; successfully complete the technical training course and obtain a satisfactory employer's report.
- \* Education — a minimum requirement is the completion of grade 11 with Mathematics 20 or its equivalent, or a pass on an equivalent entrance examination as prescribed by the trade regulation.
- \* Age — the minimum age for apprentices is 16 years. There is no upper age limit.

## **Credits:**

- \* Accelerated patterns of apprenticeship may be granted for related technical training and/or experience.

## **Benefits:**

- \* Apprenticeship is a learning-while-earning program. While working at the trade during apprenticeship, apprentices are assured by regulation of a minimum percentage of journeyman rates; 40% during the first period, 50% during the second period, 60% during the third period, 75% during the fourth period. Progress from one rate to the next takes place only after successful completion of all the requirements for each period.
- \* All apprentices 17 years of age and older are normally eligible for training allowances while attending technical training courses. These allowances are funded by the Canada Employment and Immigration Commission.
- \* Administrative procedures establishing the amount of training allowance is complex and can vary with an individual's circumstances. Contact a local Canada Employment Centre for details.
- \* An apprentice who successfully completes the program will graduate with an Alberta Completion of Apprenticeship Certificate and a Journeyman Certificate of Qualification.
- \* The most significant benefit to the graduate apprentice is that he is well trained in technical and practical aspects of the trade and is able to make a worthwhile and productive contribution to society. Society in return, will provide an opportunity for an above-average income and successful livelihood.

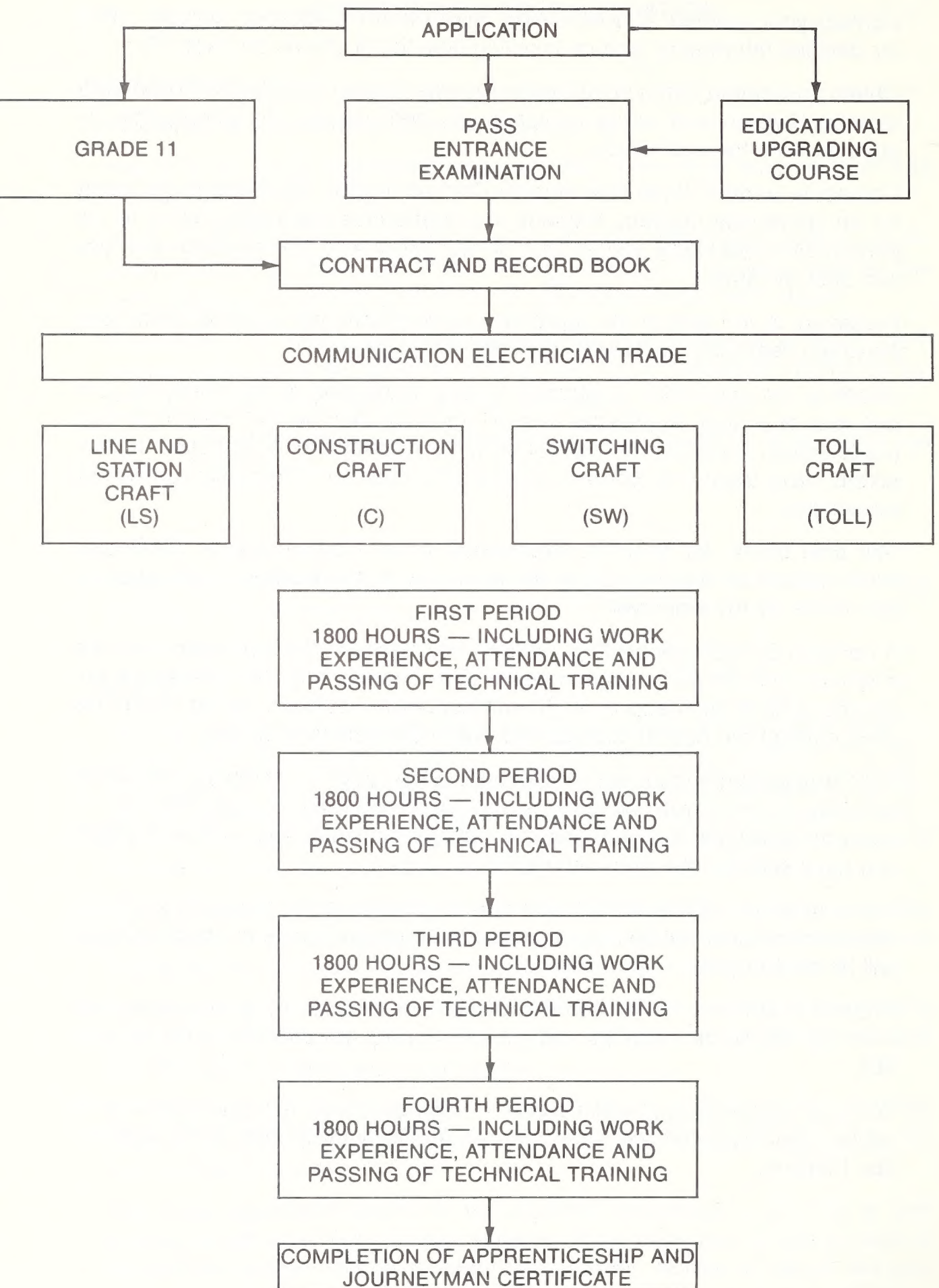


## **DIRECTIONS FOR PROSPECTIVE APPRENTICES**

- \* Contact your nearest Apprenticeship and Trade Certification Division office for detailed information and counselling (see list of offices on page 00).
- \* Obtain application forms in duplicate from the Apprenticeship and Trade Certification Division and neatly complete, on both copies, the information requested from the apprentice.
- \* Contact in person, firms that employ Communication Electricians and apply for an apprentice position. Present your apprentice application forms to the person who interviews you so that he will know who you are and what you can offer his firm.
- \* Persevere in the search for apprentice employment and upon obtaining employment, leave the application with the employer.
- \* Attach to the apprentice application a copy (transcript) of the marks for your last year of school. Applicants who do not have their school transcripts or a grade eleven standing are required to write an entrance examination. If transcripts have been lost, contact Alberta Education for information on school transcripts.
- \* Any time credit, for previous experience in the Communication Electrician trade, should be discussed with the employer and requested on the application forms by the employer.
- \* A contract of apprenticeship is entered into between the apprentice and the employer and should be signed within three months after the apprentice applications have been approved. If contracts have not been issued within this time, contact the Apprenticeship and Trade Certification Division.
- \* Before signing the contract of apprenticeship read the complete document carefully — know your obligations and responsibilities to your employer — know the employer's obligations and responsibilities to you — feel confident you have selected the right occupation.
- \* Know when you will be expected to attend classes and be prepared to attend. School schedules will be sent to your employer and notice to attend classes will be sent to you.
- \* Prepare in advance for the financial obligations required of you during school training. Reference materials and school supplies are paid for by the apprentice.
- \* While an apprentice, it will be your responsibility to respond promptly to mailed directions and requests from the Apprenticeship and Trade Certification Division.



# APPRENTICESHIP ROUTE TOWARD CERTIFICATION





## **APPRENTICESHIP COMMITTEE STRUCTURE**

### **Communication Electrician Provincial Apprenticeship Committee**

The Provincial Apprenticeship Committee for the Communication Electrician Trade is comprised of members from Local Apprenticeship Committees from the cities of Edmonton and Calgary.

This Committee is concerned with the policies that guide the program and make recommendations to the Apprenticeship and Trade Certification Board and the Executive Director of the Apprenticeship and Trade Certification Division in the following areas:

- \* Contribute current information relative to changes in the trade and requirements of industry.
- \* Make recommendations for changes to existing trade regulations.
- \* Assist in updating of the training program through recommendations for revisions to the course outline and attendant examinations.
- \* Naming personnel to Technical Advisory Committees.

### **Apprenticeship Committee Members:**

Mr. D. Ashton — Calgary — Employee  
Mr. R. Flack — Calgary — Employee  
Mr. C. Barry — Edmonton — Employer  
Mr. R. Hoy — Edmonton — Employer  
Mr. L. Kelly — Edmonton — Employee  
Mr. A. Hayduk — Edmonton — Employer  
Mr. M. Grabia — Edmonton — Employee  
Mr. R. Graff — Edmonton — Employer  
Mr. W. Robbins — Edmonton — Employer (Alternate)

# **COMMUNICATION ELECTRICIAN PROGRAM LINE AND STATION CRAFT COURSE OUTLINE**

This outline has been prepared in accordance with recommendations from the Provincial Apprenticeship Committee for the Communication Electrician Trade in the Province of Alberta.

The outline was updated following consideration given to recommendations and suggestions from:

- The Provincial Apprenticeship Committee
- The Technical Advisory Committee
- Representatives from Training Institutes
- Individuals from the Telecommunication Industry

## **PROCEDURES FOR RECOMMENDING REVISION(S) TO THE COURSE OUTLINE**

Any concerned citizen or group in the Province of Alberta may make recommendations for change by writing to the Apprenticeship and Trade Certification Division, Edmonton.

It is requested that recommendations for change refer to specific areas and state references used. Recommendations received will be placed before regular meetings of the Provincial Apprenticeship Committee.



## **SAFETY EDUCATION**

Safe working procedures and conditions, accident prevention and the preservation of health is of primary importance in the Apprenticeship programs in Alberta. These responsibilities are shared and require the joint efforts of the government, employers, employees and the general public. Therefore, it is imperative that all parties become aware of circumstances that may lead to injury or harm and that safe learning experiences and environment can be created by controlling the variables and behaviors that may contribute to or cause an accident and/or an injury.

It is generally recognized that a safe attitude contributes to an accident free environment. As a result a healthy safe attitude towards accident prevention will benefit an employee by helping to avoid injury, loss of time and loss of pay.

A tradesman is possibly exposed to more hazards than any other person in the work force and therefore, should be familiar with the Occupational Health and Safety Act and Regulations dealing with his own personal safety and the special safety rules applying to each job.

### **LEGAL AND ADMINISTRATIVE ASPECTS**

#### **Employer's Responsibilities:**

Accident prevention and the provisions of safe working conditions are the responsibilities of an employer. The company is responsible for:

1. The provision and maintenance of safety equipment
2. The provision of protective devices and clothing (as required by the Occupational Health & Safety Act, General Safety Regulations)
3. The enforcement of safe working procedures
4. Adequate safeguards for machinery, equipment and tools
5. Observance of all accident prevention regulations
6. Adequate training to allow a worker to use or operate equipment in an effective and safe manner.

#### **Government's Responsibilities:**

The Apprenticeship and Trade Certification Division in conjunction with the respective Provincial Apprenticeship Committee assumes the responsibility to assure that adequate safety is reflected in the curriculum and that adequate safety instruction is presented at the training establishments.

The Occupational Health and Safety Inspection Branch assumes the responsibility for periodic inspection of the operation to ensure that regulations for industry are being correctly observed.

#### **Individual's Responsibilities:**

The employee is responsible for:

1. Knowing and working in accordance with the safety regulations pertaining to job environment and
2. Working in such a way as not to endanger himself or his fellow employees

The major factor in safety is the individual employee, his personal attitude toward safety and having an awareness of the respective safety regulation.

## LINE AND STATION CRAFT PROGRAM

### Subjects and Time Distribution

<b>First Period</b>	<b>6 Weeks</b>	<b>30 Hours Per Week</b>	<b>180 Hours</b>	<b>Page</b>
Section One:	Basic Electricity — Theory		84	9
Section Two:	Basic Electricity — Lab		54	15
Section Three:	Trade Mathematics		42	18
<b>Second Period</b>	<b>6 Weeks</b>	<b>30 Hours Per Week</b>	<b>180 Hours</b>	<b>Page</b>
Section One:	Electronic Theory		54	21
Section Two:	Electronic Lab		18	23
Section Three:	Basic Telephone Theory and Lab		54	24
Section Four:	Logic Theory and Lab		54	27
<b>Third Period</b>	<b>6 Weeks</b>	<b>30 Hours Per Week</b>	<b>180 Hours</b>	<b>Page</b>
Section One:	Transmission (Theory and Lab)		60	30
Section Two:	Microprocessors and Minicomputer concepts		72	33
Section Three:	Data Transmission (Theory and Lab)		48	35
<b>Fourth Period</b>	<b>6 Weeks</b>	<b>30 Hours Per Week</b>	<b>180 Hours</b>	<b>Page</b>
Section One:	Advanced Pabx (Theory and Lab)		108	39
Section Two:	Subscriber Carrier (Theory and Lab)		72	44



# FIRST PERIOD TECHNICAL TRAINING

<b>SECTION ONE:</b>	<b>BASIC ELECTRICITY — THEORY</b>	<b>84 Hours</b>
<b>A. Fundamental Concepts of Electricity</b>		<b>8 Hours</b>
1. Introduction to electricity		
(a) development		
(b) fundamental concepts and application		
(c) components		
(d) terminology		
2. Negative and positive polarities		
3. Electrons and protons in atoms		
4. Unit of charge — coulomb		
5. Unit of potential — volt		
6. Charge in motion — current		
7. Opposition to current — resistance		
8. Conductance		
9. Closed circuit		
10. Sources of electricity		
<b>B. Ohm's Law</b>		<b>2 Hours</b>
1. Definition in terms of E, I and R		
2. Relationship of E, I and R to solve problems		
3. Power and power dissipation in resistance		
4. Multiple and submultiple units		
5. Electric shock		
<b>C. DC Circuits</b>		<b>4 Hours</b>
1. Series		
(a) current		
(b) resistance		
(c) voltage drops		
(d) power in series circuit		
(e) equivalent circuits		
(f) analysis		
(g) effects of open and short circuits		
2. Parallel		
(a) common voltage		
(b) branch currents		
(c) total current		

- (d) total resistance
  - (e) conductance in parallel
  - (f) power in parallel circuits
  - (g) drawing parallel circuits
  - (h) analysis
  - (i) equivalent circuits
  - (j) effects of open and short circuits
3. Series — Parallel
- (a) calculate total resistance
  - (b) current division
  - (c) voltage division
  - (d) total power
  - (e) analysis of series-parallel circuits
  - (f) equivalent circuits
  - (g) wheatstone bridge
  - (h) Kirchoff's laws
  - (i) calculate voltage to reference points
  - (j) open and short circuits

**D. Director Current Meters**

**8 Hours**

- 1. Types
- 2. Construction
- 3. Measurement of current
- 4. Meter shunts
- 5. Voltmeters
- 6. Ohmmeters
- 7. Multimeters
- 8. Meter application

**E. Conductors and Insulators**

**2 Hours**

- 1. Purpose
- 2. Types
- 3. Standard wire gauge sizes
- 4. Hardware
  - (a) switches
  - (b) fuses
  - (c) pilot lamps, etc.
- 5. Wire resistance
- 6. Temperature coefficients
- 7. Ion current



8. Electron and hole charges in semi-conductors

9. Insulators

**F. Resistors**

**2 Hours**

1. Types

2. Application

3. Color coding

4. Power rating

5. Tolerance

6. Selection for circuits

7. Resistor troubles

**G. Batteries**

**4 Hours**

1. Function

2. Voltaic cell

3. Dry cell

4. Lead-acid cell

5. Specific gravity

6. Other cells

7. Internal resistance of batteries

8. Internal resistance of generators

9. Matching load resistance to generator

**H. Magnetism**

**6 Hours**

1. The magnetic field

2. Magnetic flux

3. Flux density

4. Induction

5. Air gap

6. Types of magnets

7. Shielding

8. Permeability

9. Magnetic units

(a) ampere — turns

(b) field intensity

- (c) Ohm's law of magnetic circuits
- (d) hysteresis

<b>I. Electromagnetic Induction</b>	<b>4 Hours</b>
<ul style="list-style-type: none"><li>1. Magnetic field around a conductor of current</li><li>2. Coil polarity</li><li>3. Motor action</li><li>4. Induced current</li><li>5. Lenz's law</li><li>6. Induced voltage</li><li>7. Faraday's law</li></ul>	
<b>J. Alternating Current and Voltage</b>	<b>8 Hours</b>
<ul style="list-style-type: none"><li>1. Alternating voltage generator</li><li>2. Sine wave</li><li>3. Voltage and current values for sine wave</li><li>4. Frequency</li><li>5. Period</li><li>6. Wave length</li><li>7. Phase angle</li><li>8. Time period of sine waves</li><li>9. Resistive AC circuits</li><li>10. 60 Hz line</li><li>11. Motors and generators</li><li>12. Nonsinusoidal waveforms</li><li>13. Harmonics</li></ul>	
<b>K. Inductance, Inductive Reactance and Inductive Circuits</b>	<b>12 Hours</b>
<ul style="list-style-type: none"><li>1. Induction by AC</li><li>2. Self-inductance</li><li>3. Self-induced voltage</li><li>4. How <math>E_L</math> opposes changes in current</li><li>5. Mutual inductance</li><li>6. Transformers<ul style="list-style-type: none"><li>(a) types of cores</li><li>(b) core losses</li><li>(c) types of transformers</li></ul></li></ul>	



7. Variable inductance
8. Coils in series and parallel
9. Stray inductance
10. Trouble in coils
11. Effect of  $E_L$
12.  $X_L = 2 \pi fL$
13. Inductors in series and parallel
14. Ohm's law applied to  $X_L$
15. Application of  $X_L$
16. Waveshape of  $E_L$  induced by sine wave current
17.  $E$  leads  $I$  by  $90^\circ$
18. Resistance and reactance in series
19. Resistance and reactance in parallel
20. Quality of coils
21. AF and RF chokes
22.  $L/R$  time constant
23. High voltage produced by opening RL circuits
24. Comparison of resistance, inductive reactance and impedance

**L. Capacitance, Capacitive Reactance and Capacitive Circuits    12 Hours**

1. Storage of charge
2. Charge and discharge of capacitors
3. Unit of capacitance
4. Typical capacitors
5. Color coding
6. Capacitors in series and parallel
7. Stray capacitance
8. Troubles in capacitors
9. Energy in electrostatic field of capacitance
10. How AC voltage produces AC current in capacitive circuits
11.  $X_C = \frac{1}{2 \pi fC}$
12.  $X_C$  in series and parallel

13. Ohm's law applied to  $X_C$
14. Application of capacitive reactance
15. Charge and discharge current
16.  $I$  leads  $E$  by  $90^\circ$
17.  $X_C$  in series and parallel circuits
18. Capacitive voltage dividers
19. Coupling capacitors
20. RC time constant
  - (a) long
  - (b) short
21. Universal time constant

**M. Alternating Current Circuits**

**6 Hours**

1. AC resistive circuits
2. AC inductive circuits
3. AC capacitive circuits
4. Opposite reactances
5. Reactances and resistance in
  - (a) series
  - (b) parallel
6. Real and apparent power

**N. Resonance**

**6 Hours**

1. The effect
2. Series resonance
3. Parallel resonance
4. Calculating frequency of resonance
5.  $Q$  — magnification
6. Bandwidth
7. Tuning and mistuning
8. Analysis of parallel resonant circuits
9. Damping of parallel resonant circuits
10. Choosing  $L$  and  $C$  for resonant circuits

**GENERAL OBJECTIVES:**

1. To assist an apprentice in acquiring fundamental skills in proper and safe use of electrical bench equipment including test instruments by carrying out well planned shop activities.
2. To develop a basic understanding of d-c and a-c electric circuits and components.
3. To reinforce theoretical instruction by enabling the apprentice to gain practical circuit knowledge by performing meaningful assigned experiments.

**A. Orientation**

1. Laboratory rules and procedures
2. Bench kits and tools
3. Safety
4. Basic components and their symbols
5. Standard resistor color code
6. Schematic diagrams

**B. Meters**

1. Proper use and care
  - (a) function and range switches
  - (b) reading on different ranges
  - (c) meter errors
  - (d) safety precautions
2. Power supplies
  - (a) operation
  - (b) measuring terminal voltage

**C. The Series Circuit**

1. Line current
2. Voltage and voltage drop
3. Total resistance and total power
4. Application of Ohm's law and Kirchoff's laws

**D. Parallel Circuits**

1. Total resistance
2. Line current
3. Branch current
4. Voltage and voltage drop



5. Power and resistance characteristics
6. Application of Ohm's and Kirchoff's laws

#### **E. Series — Parallel Circuits**

1. Current
  - (a) total
  - (b) branch
2. Voltage
  - (a) applied and across each branch
  - (b) across each component
3. Total resistance and total power
4. Checking resistors for open

#### **F. Voltage Dividers**

1. Characteristics
  - (a) loaded
  - (b) unloaded

#### **G. Cells**

1. Series
  - (a) opposing
  - (b) aiding
2. Parallel
3. Series — parallel
4. Care and application

#### **H. Power Supplies**

1. Internal resistance
2. Circuit efficiency
3. Maximum power transfer
4. Application

#### **I. Wheatstone Bridge**

1. Characteristics
2. Application

#### **J. Meter Construction**

1. Meter movement
  - (a) arrangement
  - (b) sensitivity
  - (c) internal resistance
  - (d) application

2. Ammeter shunts
3. Voltmeter multipliers
4. Ohmmeters
5. Multimeters

**K. Cathode Ray Oscilloscope**

1. Function, use and care
2. Operation
3. Application
  - (a) measuring voltage
  - (b) time
  - (c) measuring frequency
  - (d) phase measurement

**L. Alternating Current and Voltage**

1. Sine wave
  - (a) peak value
  - (b) RMS value
  - (c) cycle
  - (d) frequency
  - (e) wavelength
2. Angular measurement
3. Radian measure
4. Phase angle

**M. Inductance (Coils) and Inductive Reactance**

1. Effect of inductance on current in DC and AC circuits
2. Measurement of  $X_L$
3. Verify that  $X_L = 2 \pi fL$
4. Back EMF
5. Phase relations between I and E inductive circuits
6. Open coil
7. Resistance of coil
8. L/R time constant

**N. Capacitors, Capacitance and Capacitive Reactance**

1. Determining value of capacitors
2. Effect of capacitance on current in DC and AC circuits
3. Measurement of  $X_C$

4. Verify that  $X_C = \frac{1}{2 \pi f c}$

5. Phase relations between I and E in capacitive circuits

6. RC time constant

7. Capacitors in series and parallel

8. Open and shorted capacitors

#### **O. Series RLC Circuits**

1. Current and voltage

2. Verify the  $Z = \sqrt{R^2 + (X_L - X_C)^2}$

3. Series resonance

(a)  $f_r = \frac{1}{2 \pi \sqrt{LC}}$

(b) line current

(c) impedance and voltage

(d) other characteristics

(e) application

#### **P. Paralleled RLC Circuits**

1. Current and voltage

2. Impedance (Z)

3. Parallel resonance

(a) line current

(b) impedance and voltage

(c) other characteristics

(d) application

### **SECTION THREE: TRADE MATHEMATICS**

**42 Hours**

#### **A. Review of Basic Arithmetic**

1. Common fractions

2. Decimal fractions

3. Percentage

4. Factoring

5. Ratio and proportion

#### **B. D.C. Series Circuit Problems**

1. Power of ten

(a) scientific notation

(i) multiply



- (ii) divide
- (iii) raise to a power
- (iv) add and subtract
- (b) electronic calculator

2.  $E = IR$  and its variations
3.  $P = IE$  and its variations
4. Formula manipulation
5. Multi-resistor series circuits
6. Internal source resistance

### **C. D.C. Parallel and Series-Parallel Circuit Problems**

1. Parallel circuits
  - (a) application of Ohm's law and Kirchoff's laws
  - (b) power calculations
2. Series — Parallel circuits
  - (a) application of Ohm's law
  - (b) power calculations
3. Voltage divider problems
4. Wheatstone bridge problems

### **D. Trigonometric Functions**

1. Properties of a right angle triangle
2. Trigonometric ratios
  - (a) sine
  - (b) cosine
  - (c) tangent
3. Solution of right angle triangles
4. Trigonometric solution of A.C. circuits
  - (a) voltage
  - (b) current
  - (c) phase angle
  - (d) power
  - (e) impedance

### **E. Series AC Circuit Problems**

1. Resistive
2. Inductive
3. Capacitive
4. RL, RC and LRC

5. Power
6. Resonance

**F. Parallel AC Circuit Problems**

1. Resistive
2. Inductive
3. Capacitive
4. RL, RC and LRC
5. Power
6. Resonance

## SECOND PERIOD TECHNICAL TRAINING

<b>SECTION ONE:</b>	<b>ELECTRONIC THEORY</b>	<b>54 Hours</b>
<b>A. Review of Prerequisites</b>		<b>4 Hours</b>
1. Ohm's law		
2. Impedance $R$ , $X_L$		
3. Current and voltage sources		
4. Thevenin's theorem		
<b>B. Semi-Conductor Physics</b>		
1. Atomic structure of atoms		
2. Crystals		
3. Doping		
<b>C. PN Junction</b>		
1. Forward bias		
2. Reverse bias		
3. Leakage current		
<b>D. Diodes</b>		<b>8 Hours</b>
1. The rectifier diode		
2. Diode curve		
3. Bulk resistance		
4. Reverse resistance		
5. Zener diode		
6. Breakdown voltage and peak inverse voltage		
<b>E. Power Supplies (Block Diagrams)</b>		
1. Rectifiers		
2. Filters		
3. Voltage regulators		
<b>F. Junction Transistors</b>		<b>5 Hours</b>
1. Transistor theory and correct biasing		
2. Symbols		



3. Current relationship

(a)  $\alpha$

(b)  $\beta$

4. Cut off current, breakdown voltage and collector saturation voltage

**G. Transistor Biasing**

**9 Hours**

1. Base bias

2. Emitter bias

3. Collector feedback bias

4. Collector cut off current

**H. Small Signal Amplifiers**

**8 Hours**

1. Current gain and voltage gain of amplifiers

2. Base driven amplifiers

3. Emitter driven amplifiers

4. Comparisons between the three types of configurations

(a) common emitter (CE)

(b) common collector (CC)

(c) common base (CB)

**I. Power Amplifiers**

**6 Hours**

1. Operating point

2. Single ended power amplifier

3. Push-pull amplifier

**J. Oscillators**

**2 Hours**

1. Theory of operation

2. Types of oscillators

(a) RC phase shift

(b) Wien-bridge

(c) Hartley

(d) Colpitts

(e) Crystal

**K. Metal-Oxide Semiconductor Fet (Mosfet)**

**3 Hours**

1. Construction

2. Operation

3. Application, e.g. common source amplifier

<b>L. IC Operational Amplifier</b>	<b>8 Hours</b>
<ol style="list-style-type: none"> <li>1. Integrated circuit PNP and NPN transistors</li> <li>2. Dual transistors</li> <li>3. Differential amplifiers</li> <li>4. Ideal operational amplifiers</li> <li>5. Analysis of operational amplifiers</li> <li>6. Circuits (Block diagrams) <ol style="list-style-type: none"> <li>(a) the comparator</li> <li>(b) the voltage follower</li> <li>(c) inverting amplifier</li> <li>(d) the non-inverting amplifier</li> <li>(e) the summing amplifier</li> <li>(f) the subtracting amplifier</li> <li>(g) the active filter</li> </ol> </li> </ol>	
<b>M. Clipping circuits</b>	<b>1 Hour</b>
<ol style="list-style-type: none"> <li>1. Diode clipper</li> <li>2. Transistor clipper</li> </ol>	
<b>SECTION TWO: ELECTRONIC LAB</b>	<b>18 Hours</b>
<b>A. Lab Familiarization Activities</b>	
<ol style="list-style-type: none"> <li>1. Orientation</li> <li>2. Procedures</li> <li>3. Proper use of test equipment</li> <li>4. Safety</li> </ol>	
<b>B. Power Supplies</b>	<b>5 Hours</b>
<ol style="list-style-type: none"> <li>1. Construction of a full wave power supply with various types of filters and using zener diodes for regulation</li> <li>2. Measuring DC output and ripple</li> <li>3. Relating Lab observations to theoretical explanations</li> </ol>	
<b>C. Transistor Circuit Familiarization</b>	<b>2 Hours</b>
<ol style="list-style-type: none"> <li>1. Recognizing different transistor biasing arrangements</li> <li>2. Perform "Go-No-Go" checks on the transistor using VOM</li> <li>3. Determining whether a transistor is NPN or PNP using a VOM</li> <li>4. Identifying transistor terminals using a VOM</li> </ol>	

- D. Common Emitter Amplifier** **4 Hours**
1. Measuring voltage gain
  2. Phase relations between input and output voltages
  3. Measuring input and output impedance
  4. Troubleshooting common emitter amplifiers by comparing calculated and measured values
- E. Oscillator Circuits** **2 Hours**
1. Construction of an oscillator circuit
  2. Calculation and measurement of oscillator frequency
- F. Operational Amplifiers** **4 Hours**
1. Construct an operational amplifier
  2. Calculate and measure the gain of an operational amplifier
  3. Study feedback effect
  4. RC active filter

**SECTION THREE: BASIC TELEPHONY** **54 Hours**

- A. Basic Telephone Set** **3 Hours**
1. Basic components, their symbols and theory of operation
    - (a) transmitter
    - (b) receiver
    - (c) rotary dial
    - (d) touch-tone dial
    - (e) hookswitch
    - (f) ringer and capacitor
      - (i) metallic
      - (ii) ground
    - (g) network
      - (i) sidetone
      - (ii) anti-sidetone
    - (h) terminals
- B. Telephone Type** **3 Hours**
1. Circuit analysis and comparison of:
    - (a) N.E. Co. 500 telephone
    - (b) N.E. Co. 554 FRN set
  2. Station Protection
    - (a) protectors
    - (b) grounding



3. Line characteristics

- (a) line voltage
- (b) line current
- (c) ringing voltage

**C. Telecommunication Systems**

**2 Hours**

1. The North American Network

- (a) intra-office calls
- (b) inter-office calls
  - (i) local
  - (ii) long distance
- (c) North American numbering scheme
- (d) North American switched network
  - (i) 5 classes of offices
  - (ii) define: 2 and 4 wire switch

2. Block diagram of telecommunication system

- (a) subscriber station equipment
  - (i) telephone sets
  - (ii) key equipment
  - (iii) PABX
- (b) telephone switching system
  - (i) eight basic functions of switching
  - (ii) progressive control system
  - (iii) electromechanical common control system
- (c) multiplex systems
  - (i) carriers
  - (ii) coaxial carriers
- (d) radio systems
  - (i) HF and VF
  - (ii) microwave
  - (iii) satellite
- (e) fiber optic transmission system

**D. Relays General**

**6 Hours**

1. Definition and theory of operation

- (a) operate current
- (b) non operate
- (c) release, etc.

2. Relay parts and terminology

- (a) relay contact operations
- (b) types of materials for contacts
- (c) relay windings
  - (i) same direction
  - (ii) differential
  - (iii) non-inductive

3. Relay types
  - (a) wire spring
    - (i) use
    - (ii) contact arrangement
  - (b) miniature relays
    - (i) use
    - (ii) contact arrangement
  - (c) reed relays
    - (i) use
    - (ii) contact arrangement

## **E. Print Reading**

- |   |                |
|---|----------------|
| 1. Review of schematic symbols  | <b>2 Hours</b> |
| 2. Sectionalized detached schematic (SA1)   | <b>6 Hours</b> |
| <ol style="list-style-type: none"> <li>(a) index</li> <li>(b) F.S.</li> <li>(c) apparatus figures</li> <li>(d) notes</li> <li>(e) sequence charts</li> <li>(f) circuit arrangements tables</li> <li>(g) cabs</li> </ol> |                |
| 3. Transistor — CKT prints  |                |
| 4. Attached non-sectionalized (WESCOM)  | <b>4 Hours</b> |
| 5. Electronic Key System prints (CK530)   | <b>2 Hours</b> |

## **F. Battery, Ringing and Tone Supplies**

**3 Hours**

1. Talk and signal battery
2. Tone supplies
  - (a) dial tone
  - (b) high, low, class of service tones
  - (c) line busy
  - (d) all trunks busy
  - (e) coin tones
  - (f) recorder warning
3. Ringing and ring back schemes
  - (a) urban
  - (b) rural
4. Measuring and identifying tones (Lab)

## **G. Basic Switching System Functions**

**2 Hours**

1. Interconnecting
2. Control
  - (a) connect and disconnect
  - (b) answer and hang-up

3. Alerting
4. Attending
5. Information receiving
6. Information transmitting
7. Busy testing
8. Supervision
9. Illustration of each function using SA1 type office

#### **H. Introduction to Key Equipment 6 Hours**

1. History
2. Block diagram of CK530
  - (a) function of cards
3. Concepts of Electronic Key Systems
  - (a) vantage 12
  - (b) NEC
  - (c) Tie

### **BASIC TELEPHONE LAB 12 Hours**

#### **A. Telephone Troubles**

1. Type 554
2. Type 500

#### **B. Relay Jobs**

1. Troubleshooting using prints and wire spring relays

### **SECTION FOUR: LOGIC THEORY 54 Hours** **(THEORY – 42 Hours, LAB – 12 Hours)**

#### **A. Number Systems 4 Hours**

1. Study of decimal system as an introduction to:
  - (a) binary
  - (b) binary coded decimal
  - (c) octal
  - (d) hexadecimal
  - (e) other codes, i.e. ASCII, EBCDIC

#### **B. Basic Logic Circuits 14 Hours**

1. Introduction to Boolean Algebra
2. AND, OR, NOT

3. Truth tables
4. Simple multilevel functions
5. Simple logic circuits
  - (a) AND
  - (b) NOR
  - (c) NOT
  - (d) 2 or 3 level
6. Universal logic
  - (a) NAND
  - (b) NOR
  - (c) realization of multi-level functions

**C. Flip Flops 8 Hours**

1. S-R NAND circuit study
2. D type NAND circuit study
3. J-K MS1 version — external characteristics
4. Applications of J-K, i.e. D flip flop, T flip flop, etc.

**D. Counters, Encoders, Registers 6 Hours**

1. Counters, synchronous, asynchronous
  - (a) simple binary counter
  - (b) MS1 counter circuits
2. Encoders
  - (a) decimal to binary and BCD
  - (b) binary, BCD to decimal
  - (c) MS1 coder circuits
3. Registers
  - (a) serial in serial out
  - (b) serial in parallel out
  - (c) parallel in serial out
  - (d) parallel in parallel out

**E. Memory 2 Hours**

1. Principles of semi-conductor memory
2. Magnetic tape principles

**F. Other Devices 8 Hours**

1. Astable multivibrators
2. Monostable multivibrators
3. Schmitt trigger
4. Timers



5. Display devices
  - (a) 7 segment
  - (b) led
6. Optical couplers
7. Tristate logic
8. Buffers

**G. Lab Familiarization Activities**

**12 Hours**

1. Orientation
2. Procedures
3. Proper use of test equipment
4. Safety, etc.

**H. Combinational Circuits**

1. Build several simple NAND circuits and test for operation

**I. Flip Flops**

1. Build and test RS and D type flip flops using NAND gates
2. Test MSI J-K flip flop

**J. MSI Logic Chips**

1. Check the operation of a counter and decoder considered in theory

## THIRD PERIOD TECHNICAL TRAINING

<b>SECTION ONE:</b>	<b>TRANSMISSION: THEORY AND LAB</b>	<b>60 Hours</b>
<b>A. Decibels</b>		<b>8 Hours</b>
1. Logs, dB, dBm		
2. dB meters, Pegglemesser		
3. O TLP		
4. Level measurements		
(a) dB		
(b) loss		
<b>B. Message Channel Objectives</b>		<b>2 Hours</b>
1. Purpose of a transmission system		
2. Objectives in reference to		
(a) level		
(b) distortion		
(c) crosstalk		
(d) echo and singing		
(e) noise		
(f) expectation of customer		
<b>C. Speech and Hearing</b>		<b>2 Hours</b>
1. Energy distribution		
2. Normal receive level at telephone receiver		
3. Hearing is on logarithmic basis		
<b>D. Types of Messages</b>		<b>2 Hours</b>
1. Speech		
2. Data		
3. Video		
<b>E. Types of facilities</b>		<b>2 Hours</b>
1. Paired cable		
2. Coaxial cable		
3. Multiplex and radio		
4. Open wire		
5. Wave guide		

<b>F. Attenuators</b>	<b>6 Hours</b>
<ol style="list-style-type: none"> <li>1. Purpose</li> <li>2. Types (T, PI, L, Square, H pads)</li> <li>3. Characteristic impedance and loss</li> </ol>	
<b>G. Transmission Lines</b>	<b>12 Hours</b>
<ol style="list-style-type: none"> <li>1. Characteristic impedance and why it is important to know</li> <li>2. Characteristic impedance depends on R, L, C and G called primary constants</li> <li>3. Variation of <math>Z_0</math> with frequency (examples)</li> <li>4. Propagation constant <ol style="list-style-type: none"> <li>(a) type of information one can derive from it</li> <li>(b) <math>V_p</math> decreases when line loss increases</li> <li>(c) examples of loss and <math>V_p</math> on a cable pair, e.g. 22 gauge</li> </ol> </li> <li>5. Reflection <ol style="list-style-type: none"> <li>(a) cause and effect</li> <li>(b) how to reduce reflection</li> </ol> </li> <li>6. Standing waves <ol style="list-style-type: none"> <li>(a) cause</li> <li>(b) VSWR</li> <li>(c) bad effects</li> </ol> </li> <li>7. LAB job on transmission characteristics using Lear Siegler artificial line</li> </ol>	
<b>H. Equalization (Amplitude and Delay)</b>	<b>2 Hours</b>
<ol style="list-style-type: none"> <li>1. What is it</li> <li>2. When is it used</li> </ol>	
<b>I. Loading</b>	<b>4 Hours</b>
<ol style="list-style-type: none"> <li>1. Why is it used</li> <li>2. Coil spacing and build out capacitors</li> <li>3. Used for VF</li> <li>4. Two end sections and impedance compensators</li> </ol>	
<b>J. Hybrid Circuits</b>	<b>2 Hours</b>
<ol style="list-style-type: none"> <li>1. Types</li> <li>2. Purpose of each type</li> <li>3. Operation of transformer hybrid</li> </ol>	

- K. Four Wire Termination Sets** **6 Hours**
1. Function
  2. Most important design feature (separate receive from transmit)
  3. Insertion loss, hybrid loss, trans-hybrid loss
  4. Return loss and echo return loss
  5. Singing
  6. Standard test tone levels
  7. Balancing network
- L. Noise** **4 Hours**
1. Types and causes (use lab, demonstrations)
  2. Interfering effect on speech and data
  3. Noise units dBa, dBrnc
  4. Noise meter
  5. Example of noise measurement, e.g. idle noise
  6. Noise mitigation techniques
- M. Via Net Loss (Terminology)**
- N. Loop Design (Urban and Rural)** **8 Hours**
1. Loop resistance for switching offices
  2. Cable gauges
  3. Loop losses
  4. Interoffice trunks
  5. Loading and repeaters
  6. DC resistance
  7. Sweep measurements (level traces)
  8. Pulse echo meter
  9. Telephone set — type 500
  10. Ringing isolator



**SECTION TWO:****MICROPROCESSOR AND  
MINICOMPUTER CONCEPTS  
THEORY AND LAB****72 Hours****A. Basic Review of Logic****2 Hours**

1. Terms and conventions
2. Number systems and codes
  - (a) binary, octal and hexadecimal and decimal numbering systems
  - (b) conversions
3. Logic and hardware basics
  - (a) logic gates
  - (b) truth tables
  - (c) logic symbols
  - (d) types of registers
  - (e) flip-flops

**B. Computer Arithmetic****3 Hours**

1. Addition and Subtraction
  - (a) binary
  - (b) hexadecimal

**C. System Overview of Computers****2 Hours**

1. Types
2. Differences
3. Definition
4. Major components
5. Capabilities and limitations

**D. Main Memory****4 Hours**

1. Functional description of core and semiconductor memories
2. Interleaving concepts
3. Read only memory
4. Cache memory
5. RAM

**E. Central Processor****3 Hours**

1. Major components
2. Arithmetic — logic
3. Major registers and functions

	<ol style="list-style-type: none"> <li>Typical instruction cycles</li> <li>Use on console</li> </ol>	
<b>F.</b>	<b>Instruction Sets (including Lab)</b>	<b>20 Hours</b>
	<ol style="list-style-type: none"> <li>Instruction format</li> <li>Addressing techniques</li> <li>Typical instruction sets</li> <li>Development of simple programs using instruction sets</li> </ol>	
<b>G.</b>	<b>Bus Structures</b>	<b>2 Hours</b>
	<ol style="list-style-type: none"> <li>Typical bus configuration</li> <li>Serial versus parallel transfers</li> <li>Major functions of interfaces</li> <li>Interrupt levels</li> </ol>	
<b>H.</b>	<b>Input/Output Techniques (including Lab)</b>	<b>10 Hours</b>
	<ol style="list-style-type: none"> <li>Programmed data transfer</li> <li>Program interrupts</li> <li>Priority techniques               <ol style="list-style-type: none"> <li>polling tables</li> <li>multiple interrupt lines</li> </ol> </li> <li>Direct memory access and transfer</li> <li>Channel input/output</li> </ol>	
<b>I.</b>	<b>File Organization</b>	<b>2 Hours</b>
	<ol style="list-style-type: none"> <li>Types of file organization               <ol style="list-style-type: none"> <li>sequential files</li> <li>random access</li> <li>index sequential access</li> <li>simple list organization</li> </ol> </li> </ol>	
<b>J.</b>	<b>Operating Systems</b>	<b>6 Hours</b>
	<ol style="list-style-type: none"> <li>Developing programs using tape software</li> <li>Parts of an operating system</li> <li>Batch and time sharing operating systems</li> <li>Real-time operating systems</li> </ol>	
<b>K.</b>	<b>General Software</b>	<b>4 Hours</b>
	<ol style="list-style-type: none"> <li>Process of assembly</li> <li>Comparison of high and low level language</li> </ol>	

<b>L. Languages</b>	<b>4 Hours</b>
1. Sub-routines	
2. Absolute and relocatable assemblies	
3. MACRO instruction	
4. Compilers and interpreters	
5. Comparison of basic to PL/1 and ALGOL	
<b>M. Peripheral Devices</b>	<b>7 Hours</b>
1. Survey of peripherals	
(a) TTY	
(b) video terminals	
<b>SECTION THREE: DATA TRANSMISSION</b>	<b>48 Hours</b>
<b>Theory-36 Hours — Lab-12 Hours</b>	
<b>A. A Basic Data Communications System</b>	<b>2 Hours</b>
1. Data source — computer	
2. Data encoder — modem transmitter	
3. Communications channel — telecommunications facility	
4. Data decoder — modem receiver	
5. Data link — data terminal	
<b>B. Communications Coding Structure</b>	<b>5 Hours</b>
1. Analog and digital data	
(a) analog data; analog transmission	
(b) digital data; digital transmission	
2. Transmission	
(a) serial; parallel	
3. Types of data code	
(a) binary coded decimal (BCD)	
(b) reflected (gray) code	
4. Baudot code	
(a) asynchronous and synchronous data transmission	
(b) bit rate and baud rate	
5. ASCII code	
(a) parity bits	
6. EBCDIC code	
7. Methods of error detection	
(a) vertical redundancy check	

- (b) horizontal redundancy check
- (c) cyclic redundancy check

**C. Terminals**

**2 Hours**

1. Teleprinters
2. Display terminals
3. Intelligent; semi-intelligent
4. Special purpose terminals
  - (a) FAX
  - (b) graphic terminals
  - (c) optical mark reader
  - (d) base code reader etc.

**D. Electrical Characteristics of Digital Signals**

**6 Hours**

1. Binary digital signals
  - (a) time domain
  - (b) frequency domain
  - (c) analysis of rectangular waves
    - (i) spectrum analysis
    - (ii) harmonic nulling factor
    - (iii) wave shaping
  - (d) Nyquists Theorem applied to data
2. Multilevel signals
  - (a) time domain
  - (b) frequency domain
  - (c) increasing data bit rate without baud rate using multilevel signals
  - (d) duo-binary and partial response encoding techniques

**E. Communication Links and Modes of Operation**

**2 Hours**

1. Modes of operation
  - (a) simplex mode
  - (b) half duplex mode
  - (c) full duplex mode
2. Types of data networks
  - (a) switched network
    - (i) advantages and disadvantages
  - (b) dedicated work
    - (i) point to point communications link
    - (ii) multidrop configuration
    - (iii) advantages and disadvantages

**F. The Data Communications Channel**

**4 Hours**

1. Levels in data communications
  - (a) TLP — transmission level point
  - (b) DLP — data level point (—13 dBm0)
  - (c) Tx and Rx levels in a system



2. Parameters affecting data communications

- (a) systematic and fortuitous distortions
- (b) attenuation distortion
  - (i) definition
- (c) envelope delay distortion
  - (i) definition
- (d) impulse noise
  - (i) definition
- (e) phase jitter
  - (i) definition

**G. Data Modem**

**10 Hours**

1. Basic description of a data modem

- (a) function of a modem
- (b) basic elements of a modem
  - (i) transmitter section
  - (ii) receiver section
  - (iii) control and timing section
- (c) asynchronous and synchronous transmission
- (d) classifications of modem types
  - (i) low speed
    - sub voice grade — VFCT (FDM)
    - voice grade to 1800 b/s
  - (ii) medium speed
    - voice grade modems
    - 2400 to 9600 b/s transmission
    - examples
  - (iii) high speed
    - wideband modems and facilities
    - typically 19.2 kb/s and 50 kb/s
    - examples

2. Basic modulation techniques

- (a) amplitude modulation
  - (i) amplitude shift keying
  - (ii) vestigial sideband
- (b) frequency modulation
  - (i) frequency shift keying — 103 modem
- (c) phase modulation
  - (i) phase shift keying (Bell 212A modem)
- (d) multilevel AC coding techniques
  - (i) multilevel phase modulation techniques — Bell 201 modem
  - (ii) multilevel phase and amplitude modulation techniques — QAM for 9600 bps modems
- (e) advantages of phase modulation
  - (i) fixed reference detection
  - (ii) differential detection

3. Acoustic couplers

4. EIA interface
  - (a) functions, types and general descriptions
  - (b) standard voltage levels
  - (c) individual lead function
5. The data access arrangement for the switched network

<b>H. Protocol</b>	<b>1 Hour</b>
1. SNAP	
2. X.25	
3. X.21	
<b>I. Digital Data Networks</b>	<b>2 Hours</b>
1. Digital network configuration block diagram	
2. Altanet	
3. Dataroute	
4. Datapac	
5. Envoy	
<b>J. Applications to I &amp; R</b>	<b>2 Hours</b>
<b>K. Lab</b>	<b>12 Hours</b>

**NOTE:** Entire section to be kept on a light practical appreciation level. No math, no circuit design.

## FOURTH PERIOD TECHNICAL TRAINING

### SECTION ONE: SWITCHING AND PABX (72 HOURS—THEORY AND 30 HOURS—LAB)

108 Hours

#### A. Introduction

1. Requirements of Switching (Review)
  - (a) intra-office
  - (b) inter-office
  - (c) tandem
  - (d) classes of office
  - (e) 8 basic functions of C.O.
  - (f) telecommunications system block diagram
2. Progressive Control
  - (a) review telephone
  - (b) review connector
    - (i) expansion
    - (ii) transmission bridge
  - (c) concentration — line finder
  - (d) distribution
    - (i) selector
    - (ii) DA selector
3. Common control (block diagram)
  - (a) cross bar switch
  - (b) electro mechanical control
    - (i) controller
    - (ii) register
  - (c) computer control
4. Time division switching (block diagram)

#### B. Basic PABX

4 Hours

1. Introduction to PABX's
2. Circuit pack protection
3. Develop PABX sizes
  - (a) mitel
    - (i) SX-10
    - (ii) SX-20
    - (iii) SX-100/200
  - (b) plessey
    - (i) K1-M

#### C. EPABX (SX-20)

15 Hours

1. Features
2. Terminology

3. Hardware structure
4. Data structure
5. Data entry

**D. Basic PABX**

**5 Hours**

1. Definition
2. Function
3. Types of multiplex
  - (a) space
  - (b) time
4. Direct in dial
  - (a) applications
  - (b) limitations
5. Ring-down
  - (a) applications
  - (b) limitations
6. Centrex C.O. (central office)
  - (a) applications
  - (b) limitations
7. Centrex C.U. (subscriber building)
  - (a) applications
  - (b) limitations
8. Switched loop
  - (a) applications
  - (b) limitations
9. Key per trunk
  - (a) applications
  - (b) limitations
10. PABX features
  - (a) tie lines
  - (b) foreign exchange lines
  - (c) direct trunking
  - (d) tandem
  - (e) route restrictors

**E. Common Control PABX**

**13 Hours**

1. Review of progressive control
2. Common control introduction
  - (a) three sections
    - (i) network
    - (ii) interface
    - (iii) control



3. Advantages of common control over progressive control

- (a) numbering plan
- (b) trunking arrangements
- (c) types of pulsing
- (d) classes of service
- (e) double connections
- (f) new features
- (g) overload reaction

4. Space division grid switching devices

- (a) crossbar switch
  - (i)  $10 \times 10$
  - (ii)  $10 \times 20$
  - (iii) mechanical operation
  - (iv) select fingers
  - (v) select magnets
  - (vi) hold magnets
  - (vii) steer select
  - (viii) steering levels
  - (ix) splitting relays
  - (x) stacking switches with common steering
  - (xi) matrix size
  - (xii) 3 wire switching
  - (xiii) 6 wire switching
  - (xiv) banjo splitting, e.g. NA-1000
- (b) the read switch
  - (i) non latching
  - (ii) latching
  - (iii) speed
  - (iv) electrical characteristics
  - (v) interconnection to form matrix
- (c) the solid state switch
  - (i) requirements
  - (ii) network size
  - (iii) comparison of types of crosspoints

5. Control of switching grids

- (a) marker control
- (b) marker connector

6. Service equipment

- (a) registers
  - (i) ringing tone circuits
  - (ii) supervision
  - (iii) detect pulse train
  - (iv) digit counting
  - (v) digit storage
  - (vi) prefix translation
  - (vii) line location and class mark storage
  - (viii) route restriction

- (b) translators
    - (i) called prefix to trunk group
    - (ii) called number to line location
    - (iii) calling location to calling number
  - (c) DTMF pulse convertors
  - (d) senders
    - (i) dial pulse
    - (ii) multifrequency
7. Trunk circuits
- (a) types
  - (b) signalling
    - (i) C.O.
    - (ii) loop
    - (iii) dial tone
    - (iv) D.O.D.
    - (v) D.I.D.
    - (vi) tie
    - (vii) foreign exchange
  - (c) hold forward and back
  - (d) supervision

## **F. Principles of Digital Switching Review**

**4 Hours**

1. Introduction
2. Sampling
3. Quantizing
4. Coding
5. Framing
6. Space and time
7. Switching in time
8. Switching through time

## **G. PABX (SL-1) (Including Lab)**

**40 Hours**

1. Introduction
  - (a) system features and services
2. Block diagram
  - (a) system partitioning
  - (b) CE partitioning
  - (c) DE partitioning
  - (d) purpose of the circuit pack
3. Equipment cabinets
  - (a) CE cabinet
  - (b) PE cabinet
  - (c) power distribution

4. Memory, data, and program
  - (a) resident and non-resident programs
  - (b) firmware
  - (c) software
  - (d) data blocks
  - (e) memory partitioning
  - (f) memory administrator
5. Equipment configuration
  - (a) high and low priority buffers
  - (b) call registers
  - (c) output buffers
  - (d) memory requirements
  - (e) PE, loop, and cabinet requirements
6. Installation and testing
  - (a) terminal installation and data block generation
  - (b) uses of overlay programs
7. Enhanced features
  - (a) auto-call directing
  - (b) centralized attendant service
  - (c) message center
  - (d) data modules
  - (e) electronic switching center

**H. Stored Program Control Electronic Analog PABX  
(Plessey K-1) (Including Lab.)**

**23 Hours**

1. Introduction
2. System capacities
3. Cabinet components and functions
4. Station features and options
5. Console
6. System programming

**I. 4-Wire Key Set**

**4 Hours**

1. Introduction
2. Block diagram
3. Features

<b>SECTION TWO:</b>	<b>SUBSCRIBER CARRIER</b>	<b>72 Hours</b>
	<b>THEORY-54 HOURS — LAB-18 HOURS</b>	
<b>A. Definition and Requirements for Multiplex</b>		<b>1 Hour</b>
<b>B. Types of Multiplex</b>		<b>10 Hours</b>
1. Frequency division multiplex		
(a) amplitude modulation		
(b) frequency modulation		
2. Time division multiplex		
(a) pulse amplitude modulation		
(b) pulse code modulation		
(c) delta modulation		
<b>C. Subscriber Carrier Basics</b>		<b>3 Hours</b>
1. Central office terminal		
(a) requirements		
(b) functions		
2. Remote terminal		
(a) requirements		
(b) functions		
3. Repeater and line power feed		
(a) requirements		
(b) functions		
4. Concentration		
(a) requirements		
(b) functions		
<b>D. Basic Characteristics and Functions of Each of the Components in a FDM System</b>		<b>6 Hours</b>
1. Hybrid		
2. Modulators		
3. Oscillators		
4. Filters		
5. Regulation		
6. Equalization		
7. Signalling		
8. Compandors		
9. Power feed and protection		



**E. Study of a Specific FDM Subscriber Carrier (S6A and CM8) 11 Hours**

1. Central office terminal
  - (a) physical layout
  - (b) block diagram
  - (c) options
2. Remote terminal
  - (a) physical layout
    - (i) shelf
    - (ii) distributed
  - (b) block diagram
  - (c) options
3. Repeaters
  - (a) physical layout
  - (b) block diagram
  - (c) options

**F. Principles of a TDM System 6 Hours**

1. Sampling
2. Quantizing
3. Encoding
4. Synchronization
5. Framing
6. Signalling

**G. Study of a Specific TDM Subscriber Carrier (DMS-1) 11 Hours**

1. Central office
  - (a) physical layout
  - (b) block diagram
2. Remote terminals
  - (a) physical layout
  - (b) block diagram
3. T1 repeatered line
  - (a) span
  - (b) span line
  - (c) spare switching
  - (d) physical layout
  - (e) block diagram
  - (f) fault location
  - (g) order wire

**H. Fiber Optic Carrier 6 Hours**

1. Basic concepts
2. Types of cable

3. Losses in fiber
4. Distortion in fiber
5. Splicing/connectors (problems)
6. Terminal and repeater equipment
  - (a) LED
  - (b) laser
  - (c) photo diodes
  - (d) avalanche photo detectors
7. Present applications/systems
8. Future trends/possibilities

**I. Lab**

**18 Hours**

## **SUGGESTED REFERENCE MATERIALS**

Basic Electronics — Grob — McGraw Hill — 5th Edition

Basic Mathematics for Electronics — Cook and Adams — 4th Edition

Basic Telephone Switching Systems — Talley —  
Hayden Book Company — 1969

Principles of Electricity Applied to Telephone and Telegraph Work —  
A.T.&T. Co. — 1961 Edition

Transmission for Telecommunications — Clarke — S.A.I.T. Publication

Telephone Principles — TXT 222 — S.A.I.T. Publication

Elementary Communications — N.A.I.T. Publications

Electronic Principles — Malvino — McGraw Hill — 2nd Edition

Microprocessors and Minicomputers Hardware and Software —  
Tocci — Prentice Hall

Digital Principles and Applications — Malvino/Leach —  
McGraw Hill — 2nd Edition

## **TECHNICAL TRAINING SCHOOLS**

The Communication Electrician apprenticeship training program is offered by Alberta Manpower, Apprenticeship and Trade Certification Division. Staff and facilities for teaching the program are supplied by:

1. Northern Alberta Institute of Technology
2. Southern Alberta Institute of Technology

## **LOCATION OF APPRENTICESHIP AND TRADE CERTIFICATION DIVISION REGIONAL OFFICES**

BONNYVILLE

CALGARY

EDMONTON

FORT McMURRAY

GRANDE PRAIRIE

HINTON

LETHBRIDGE

MEDICINE HAT

PEACE RIVER

RED DEER

VERMILION



**ALBERTA REGULATION 93/80**

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*(Filed on March 14, 1980)*

THE MANPOWER DEVELOPMENT ACT

DEPARTMENT OF ADVANCED EDUCATION AND MANPOWER

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MINISTERIAL ORDER

I, James D. Horsman, Minister of Advanced Education and Manpower, pursuant to sections 30(2) and 37(2) of The Manpower Development Act, hereby make regulations in the Appendix attached hereto, being the Communication Electrician Trade Regulation.

Dated at the City of Edmonton, in the Province of Alberta, this 12th day of March, 1980.

JAMES D. HORSMAN,  
Minister of Advanced Education and Manpower.

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APPENDIX

THE MANPOWER DEVELOPMENT ACT

Communication Electrician Trade Regulation

1(1) In this regulation

- (a) "communication electrician" means a person engaged in the construction, installation and maintenance of telecommunication systems;
- (b) "General Regulations" means the General Regulations under The Manpower Development Act, (Alta. Reg. 43/77) as amended;
- (c) "trade" means the trade of communication electrician.

(2) The definitions in the General Regulations apply in this regulation.

Part 1

APPRENTICESHIP AND TRADE TRAINING

2 A person is eligible to be an apprentice who has

- (a) satisfied the requirements of section 5 of the General Regulations, and
- (b) completed grade 11 with Mathematics 20 or its equivalent, or passed an entrance examination prescribed by the Board.

3(1) Subject to subsection (2), an employer who is a journeyman or employs a journeyman may employ one apprentice, and for each additional journeyman he employs, he may employ one additional apprentice.

(2) The Director may authorize an employer to employ an apprentice, in addition to those permitted under subsection (1), on a temporary basis, to train him in a branch of the trade not engaged in by the employer to whom he is apprenticed.

(3) An apprentice employed temporarily under subsection (2) shall not, for the purposes of subsection (1), be considered to be an apprentice of his temporary employer.

4(1) The term of apprenticeship shall consist of four periods of 12 months each.

(2) Each period referred to in subsection (1) shall consist of not less than 1800 hours of on the job training, inclusive of time spent attending technical courses prescribed by the Board.

(3) The Director may not, under section 25(1) of the Act, reduce the term of apprenticeship to be served by an apprentice to less than one period of apprenticeship.

5 When a contract of apprenticeship is registered with the Director, he shall issue to the apprentice an official record book referred to in section 14 of the General Regulations.

6(1) An apprentice shall not advance to the next period until the Director has authorized him to do so by making an entry in the apprentice's official record book under subsection (2).

(2) The Director shall make an entry in the apprentice's official record book authorizing advancement to the next period, when the apprentice



- (a) has completed the previous period of apprenticeship.
- (b) has received, in the opinion of the Director, a satisfactory report from
  - (i) his employer, and
  - (ii) the school at which he attended technical training courses prescribed by the Board.
- (c) has completed the tests and examinations prescribed by the Board, and
- (d) has attained pass marks prescribed by the Board, in the tests and examinations referred to in clause (c).

7 The official record book of an apprentice shall be kept in the possession of his employer and, upon termination of employment of the apprentice, the employer shall present the book to him.

8(1) An employer shall pay wages to the apprentice that are not less than the following percentages of the prevailing wages paid to a journeyman:

- (a) 40% in the first period;
- (b) 50% in the second period;
- (c) 60% in the third period;
- (d) 75% in the fourth period.

(2) Notwithstanding subsection (1), the wages paid to an apprentice shall not be less than the minimum wage fixed pursuant to The Alberta Labour Act, 1973.

(3) An employer is not required to pay an apprentice wages during the time that the apprentice spends attending technical training courses prescribed by the Board.

9 The hours of work and working conditions of an apprentice shall be the same as those of a journeyman.

## Part 2

### CERTIFICATION

10 In addition to section 32 of the General Regulations, the Director may issue a Certificate of Qualification for the trade of communication electrician without examination to a person who holds

- (a) a Certificate of Completion of Apprenticeship in the trade issued by another province within Canada, or
- (b) a Certificate of Qualification or a Certificate of Proficiency in this trade issued by another province within Canada bearing an Interprovincial Standards Red Seal.

11(1) An application to take an examination for a Certificate of Qualification shall be made to the Director.

(2) Documentary evidence acceptable to the Director shall be presented by an applicant for an examination showing that the applicant

- (a) holds a certificate equivalent to an Alberta Certificate of Qualification issued by a recognized provincial authority outside of Alberta, or
- (b) has at least 4 years of acceptable work experience in the trade.

(3) The applicant shall provide translations into the English language, acceptable to the Director, of credentials other than in English submitted pursuant to subsection (2).

12 Certificates of Qualification issued under this regulation are effective unless cancelled or suspended by the Director in accordance with sections 42 and 43 of the General Regulations.

13 Alberta Regulation 570/64 is repealed.



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